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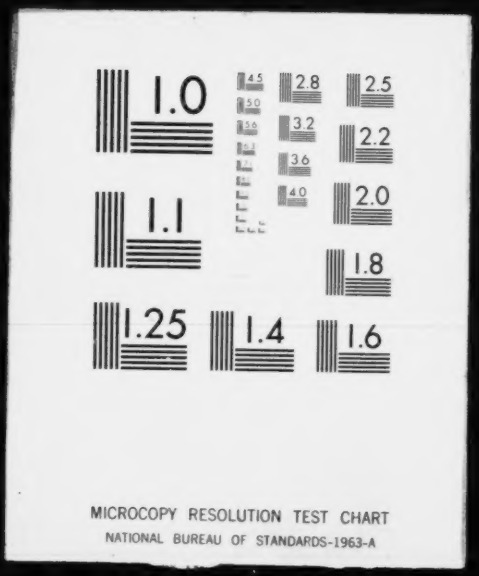

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ABSTRACT

The role of performance evaluation and testing in the development of an operational accountability system for urban public schools is discussed. Management science techniques and concepts and econometric methods are used to specify an accountability system, determine its data requirements, and evaluate alternative measures of systems performance. Empirical data, derived from surveys of administrative and teaching personnel in the Pittsburgh public school system and from the system's pupil and financial data files, are used in an examination of structural relationships among resource flows and the domains of administrative and teacher authority. Such analyses are shown to be prerequisite to the implementation of complete accountability systems in public education. (Author)

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Operational Accountability

by

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February 26, 1973

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1. Introduction

The accountability notion is very current in the educational literature[1] and numerous sophisticated models of accountability systems or procedures are available.[2] This heightened interest is probably due to the promise accountability seems to hold for increasing the productivity and operational effectiveness of educational systems. Since it serves these purposes for large organizations in the private sector the natural asumption is that it would function similarly in large educational systems. Nonetheless, few school systems have carried out the vast changes in standard operating procedures which the available constructs and models require. This failure to implement accountability can be traced on the one hand to a dirth of operational techniques for determining where in each individual school system accountability concepts can be usefully incorporated with minimal change in normal practice and, on the other, to the unfortunate assumption that accountability must be implemented on an all or nothing basis.[3]

In this paper we describe the results of a preliminary study of accountability in an urban public school system. In the study we use empirical data routinely collected by the school system for internal purposes. This study is part of a larger project funded by a grant from the US Office of Education in which we are attempting to develop a general methodology for operationalizing accountability in the public schools. Since our conceptualization of the issue and approach to operationalizing accountability differ from most it will be useful to briefly describe our view prior to presenting the empirical results of the study.

2. Accountability - What we mean by it

We view accountability from the perspective of private sector production systems where the term is applied to several kinds of overall management planning and control processes which increase the likelihood that resources will be obtained and utilized efficiently at all levels of production.[4] In general, accountability procedures achieve this goal not simply by holding managers accountable to owners, but by providing relevant information to decision makers throughout the organization. When applied to operating procedures in public school systems the accountability notion requires modification because of the simultaneous owner-consumer roles played by the public, the absence of a market in the economic sense and the absence of the desire to achieve profit maximization to motivate the efficient use of resources.[5]

These differences lead us to respecify the construct. To convert the theoretical business-management oriented construct into a concept with empirical content and relevance for school system operations we define accountability in terms of a set of hypotheses (capable of refuteation) which are based upon measureable variables and relationships. Operationalizing the construct adds the further requirement of posing these hypotheses so that they mesh with the stated goals of the school system and can be, at least initially, tested with data which are easily derived from the day-to-day operations of the system.[6]

We begin by <u>assuming the existence of a set of output performance measures</u> for students based upon meaningful testing procedures administered regularly, uniformly, and throughout the school system. Without performance measures, the construct of accountability has no empirical content thereby preventing its operationalization.

Secondly, we hypothesize the existence of both measurable controllable and non-controllable inputs and resources into the educational process. The controllable variables can be thought of as instruments for effecting change in the output performance measures, whereas the non-controllable variables are parametric and must be treated by the decision makers at that level as given (or specified) to them as part of their environment.

Inputs here include program and process variables as well as the "flow" and "state" variables of customary input/output models. The important point is that if all inputs are uncontrollable, "accountability" is not operational. That is, unless individuals can exercise control over the resource they employ or the programs they use, they cannot be held responsible for their performance. Conversely, if individuals influence an instrumental variable, then to some degree they are responsible for the outcome of the process.

Third, we hypothesize a relationship between inputs and performance measures at each level of responsibility. That is, we treat each level of responsibility as a unit of analysis for selecting the population of performance measures the relevant controllable and non-controllable inputs, and the appropriate relationships. These levels of responsibility correspond to domains of interest - be they those of administrators or consumer groups - and they give rise to researchable issues and hypotheses which increase in specificity as the level of performance is disaggregated and concern with resource allocation becomes more individualized.[8,9]

An important point should be made here regarding the selection of inputs to operationalize "accountability" only those inputs which affect the performance measures should be used. However, because the educational

process is not precisely known, we can only hypothesize which inputs to include. Therefore, ex ante, we must begin with a surplus or even redundant, set of input data and, ex post, decide which will be useful. The implication here is that an extensive data file on input data is a probable prerequisite to an operational accountability system. Furthermore, we should note that the decomposition of input variables into controllable and non-controllable is often arbitrary and dependent on the level of analysis. For example, while an individual teacher may have no control over the racial mix in the classroom the school system administrators, through busing programs and amalgamation of schools, do.[10] Additionally, some variables which are assumed to be uncontrollable, such as aptitude may, in fact, be amenable to control or change in response to special programs.

One last assumption involves our ultimate conceptualization of the accountability system as an evolving unit. We assume that control over the kind and quality of data at the disposal of the system will be eventually forthcoming and that the goals of the research and levels of analysis will vary as a result of decisions made within the accountability system. Thus, we see operational accountability being implemented gradually as levels of responsibility within the school system are penetrated and as objectives and data requirements are redefined, resources reallocated and inputs altered.[11]

3. The preliminary study

These are our priors. They direct us to treat each level of responsi-

bility within a school system as a unit of analysis for selecting the population of performance measures. At the current time we are concentrating on examining the relationships between inputs and performance at the school level using data collected within the Pittsburgh Public School system: Such an examination is a first step to the development of an accountability system since it deals with the hypothesis that schools differ one from another in the aggregate performance of their students. If there are no differences in student performances at this level and if there are no differences in expenditure by school then further efforts to construct an accountability system would be fruitless. Our procedure for examining this issue is to postulate a relationship between inputs and performance at the school level, develop a model of the relationship which is amenable to estimation using multiple regressing techniques and then sift through the available data selecting those variables which most closely correspond to the requirements of the model.[12]

Since our data derive from the Pittsburgh Public Schools and we are arguing that an accountability system must be fashioned to fit the specific needs of individual school systems it is useful to briefly describe the context of our effort. The data we have describe the performance of a population of children who were in the fifth, sixth and seventh grades of the Pittsburgh Public Schools in 1970 and were still in the system in the fall of 1972. These data were originally collected as part of an ongoing research project internal to the schools and they contain student identifications, grades, age, sex, race, school location and scores on a

fifth grade administration of an IQ test (Otis-Lenon). The Metropolitan Achievement Test (MAT) battery taken in the springs of 1970 and 1971 are also included. During 1970, the Pittsburgh Public Schools enrolled 72,000 elementary and secondary students and operated 112 school facilities. We initially had records on about 9,000 students who attended 80 of the 112 schools. For those of you not familiar with Pittsburgh in 1970, the city had a population of 520,000 of whom 20.2% were black.

We postulated a relationship of the following form:

$$Y^i = f(I^i, S^i)$$

Where: (1) Y^i is a vector of measures of student performance such as the scores on system-wide tests for student i; (2) I is a vector of individual student variables for student i which, at this level of analysis, are assumed to be uncontrollable; and (3) S is a vector of school variables such as the school's identity, teachers or administrative structure, associated with individual i's school.

In our initial study we had identified the Y^i with student scores on the MAT.[13] Our file of student records contained scores for MATs taken by the pupils in the springs of 1970 and 1971. However, different editions of the MATs had been used in these years and there were other transformational difficulties. As a first pass we decided to examine only one year, 1970.

Raw scores for 6 MATs were included in the 1970 student file: Word knowledge, reading, spelling, language skills, arithmetic computation and

and arithmetic problem solving. To cut down on the number we examined and intercorrelation matrix of test scores and chose three. Word knowledge, reading and language skills correlated highly so we chose to use word knowledge. Spelling correlated the lowest with the other tests so we included it as well. Both math tests correlated highly and we chose arithmetic computation.

For the I vector we used data on the student's race, sex, grade and age and, also, as a measure of inate ability, a standardized score for a fifth grade administration of the Otis-Lenon IQ test. In this preliminary study these variables are taken as uncontrollable, they are elements of the environment in which each school must operate. However, assuming these background variables are uncontrollable is arbitrary and purely a feature of the level of the analysis.

For the S vector we chose simply to identify the schools since we wished to examine the effect of schools at a gross level. Since our interest at this stage was to determine whether there were any differences in student performances at the school level, given the differences between schools in background characteristics of students, we used no other variables to describe differences between schools.

For the time being we did not want to get involved with examining the cumulative effect of grades or the interaction of schools with grades or any other interactive effects. Thus, we chose to examine school effects within each grade separately.

We estimated the following three models for each grade in 1970 for the MATs:

$$\text{I.} \quad R_{ij} = b_0 + b_1 IQ_i$$

$$\text{II.} \quad R_{ij} = b_0 + b_1 IQ_i + b_2 D_1 + b_3 D_2 + \ldots . b_{n+1} D_n$$

$$\text{III.} \quad R_{ij} = b_0 + b_1 IQ_i + b_2 Age_i + b_3 MW + b_4 FW + b_5 MB + b_6 FB + b_7 D_1 + \ldots . . b_{n+7} D_n$$

In I, R is the raw score for individual i on one of the three MATs. IQ_i is individual i's fifth grade score on the Otis-Lenon. In II, we introduce a set of 0/1 dummy variables, D_1-D_n, for schools. When individual i is in school k it is one and all the other school dummy variables are set to zero.

The dummy school variables were constructed in the following way. For each of the three tests we computed the observed grade mean score. We then examined the means within each school and noted the school whose mean score for a given grade and test came closest to the system-wide mean. These "mean schools" were chosen as the comparison schools for each regression run.

In III, we add in the background variables. Age is brought in as a linear variable, the age in years for individual i. Sex and race are brought in as a set of paired dummy variables constructed to detect sex-race interactions. If individual i is male and is white then the MW variable is set to one and all others are zero. Similarly, when individual i is female and white the FW variable is set to one and all others are zero. The MB and FB variables are constructed similarly. We chose to compare the different sex-race effects to male-whites.

Some comments are in order on the data. We excluded from analysis all records for sex or race variable was unknown or indicated that the

individual was non-white and non-black. The total number of children excluded for this latter reason was quite small and though they could have been included it would have required an additional set of four dummy variables whose interpretation would have been questionable. We also excluded all individuals who were not in regular schools in 1970, those who were not in the fifth, sixth or seventh grades. These exclusions left us with a total sample of 8718 students, 2748 in the fifth grade, 2885 in the sixth grade and 3085 in the seventh grade.

The results of estimating equations I-III for each grade for the three tests appears in the handout along with the means and standard deviations of included variables. The fifth grade pupils were identified with 80 different schools, the sixth grade pupils with 75 and the seventh grade pupils with 44.

There are 27 regressions. The first nine appear on the upper third of the handout. To facilitate interpretation of the results, we have presented only the barest essentials. The adjusted R^2 appears as the first row of each set of nine regressions within a grade. It is followed by the independent variables. The variable "% schools" summarizes the school effects by presenting the percent of the school dummy variables which were significantly different from the comparison "mean school." Note that we can expect 5% of the schools to appear to be "significantly" different by chance alone.

To get a handle on these results we will briefly work through one set and then summarize the results contained in the others.

Consider the results for the fifth grade on the word knowledge test. When word knowledge was regressed on IQ score alone and $\bar{R}^2$ of .43 was attained and the IQ coefficient was estimated as .41. In other words, this regression estimates an increase in the word knowledge raw score of .41 for every one point increase in IQ above the mean of 98.9.

No school effects were estimated in this first run, but on the second run school dummy variables were added in. In this case the $\bar{R}^2$ increases to .49, the IQ coefficient drops slightly to .35 and 26.3% of the school dummy variables were significant at the .05 level. In every regression the percent of schools significant was always greater than 5% and, in fact, never less than 16%. Thus, we conclude that there are significant differences between schools in the performance of fifth graders on the word knowledge part of the MAT.

The third regression in this set adds in age and the sex-race dummy variables. The adjusted $\bar{R}^2$ increases to .51 and 22.5% of the schools are still significantly different from the comparison school.

It is interesting to examine in passing the coefficients for the age and sex-race dummy variables. Recall, however, that they are assumed to be uncontrollable only because of the level of analysis. Because of this the results should be interpreted cautiously. The age variable indicates that children who are older than the mean age for the grade can be expected to do worse on average on the word knowledge test. The dummy sex-race variables are to be compared with male whites. Female whites do not appear to do significantly better or worse than male whites

on the word knowledge test. However, male blacks do worse than male whites by about 3 points on average while female blacks do worse still, differing from male whites by nearly 4 points. These results need not mean that these differences are, in fact, due to innate qualities. They could just as easily derive from differential experience within the school system, socioeconomic conditions and sociocultural variables. Since we have no way of examining these possible causative relations here, we simply emphasize the need for caution in drawing conclusions concerning the operational implications of these findings.

Moving down the table while remaining under the heading for word knowledge provides stronger evidence for our earlier conclusions concerning school effects. In the sixth and seventh grade the effect attributable to IQ alone is less than in the fifth grade while the effects that appear to be associated with the schools and individual characteristics variables seem to increase in importance. In the seventh grade there is a clear-cut hierarchy of effects in the sex-race dummy variables with white males leading white females who lead black males who lead black females. The age effect is quite strong and negative. Note that the regression includes a control for IQ. In both the sixth and seventh grades even after the influence of aptitude and background characteristics are taken into account around 1/3 of the schools still show significant differences.

For spelling the effects are reasonably similar with some rearrangement in the sex race dummy variables. But even here the school effects are clear-cut.

In the case of the arithmetic computation the school effects appear to be most striking. While the background variables have effects

reasonably similar to those for the prior two tests the seventh and eighth grade school effects are the strongest in the table. Even after controlling for IQ, sex and race half of the schools in these two grades show significant differences when compared with the mean school. Furthermore, the change in $\bar{R}^2$ which occurs when these school variables are added in is greatest in these two grades.

4. Implications for future research

What this preliminary study has demonstrated is that even after the aptitude of students is considered and several background characteristics are controlled for there still appears to be variation in the performances of children associated with different schools. The inference we derive is that these differences can be associated with different inputs to the students at the school level. The next step, of course, is to isolate that portion of the school effect which is attributable to <u>controllable variables</u> which differ among the schools. Such an attempt must be made with noncontrollable variables which may effect performance also taken into consideration. Which variables are controllable and which are not will be determined by the next level of responsibility chosen for analysis. At the school level the noncontrollable variables could include the school's location, i.e., its neighborhood, and teacher factors such as student-teacher ratios. Note again that these are considered noncontrollable only because of the analytic level. The system can ultimately alter the student-teacher ratio and even the school's location. But, for purposes of analysis these are here taken as environmental variables. To

the extent that an assignment can be made between controllable input variables and performance we obtain more information concerning the marginal contribution which they make toward the successful attainment of the educational system's goals.[14]

Of course, we recognize that we cannot specify measureable variables which can be associated with all of the goals of an educational system. Indeed, it is unlikely that all of the objectives of public education can ever be made explicit let alone measureable. However, to the extent that there are goals for which successful performance can at least be estimated on some reasonably acceptable basis then what we have done is to provide initial evidence that an accountability system can be developed in a public education system using the kinds of data which the system normally generates. We believe that accountability procedures of the type we are developing would facilitate the efficient use of public funds, improve the ability of teachers to adjust to the needs of their students, and provide feedback at each level of the system so that long range planning, day-to-day control and other aspects of complete accountability systems can eventually be implemented.

We intend to pursue this research effort further. Our next steps involve the use of gain scores through conversion to grade equivalences as a replacement for raw MATs. With the cooperation of the Pittsburgh Public Schools we have amassed data on school personnel, facilities, budgets and staffing assignments. We have also gathered census data which permit us to identify neighborhood characteristics for students and staff residences. These will all be used in further specifying the relationship between inputs and performance.

TABLE 1: REGRESSION RESULTS

1970

Fifth Grade

Total Students: 2748; Total Schools: 80

	Word Knowledge			Spelling			Arithmetic Computation		
$\bar{R}^2$	.43	.49	.51	.33	.41	.43	.27	.46	.47
IQ	.41	.35	.31	.34	.28	.24	.23	.16	.15
Age			-2.09			-2.24			-.35*
FW			-.49*			2.13			-.10*
MB			-2.99			-1.32*			-2.30
FB			-3.76			-.39*			-2.30
% schools		26.3	22.5		40.0	45.0		41.3	33.8

Sixth Grade

Total Students: 2885; Total Schools: 75

$\bar{R}^2$	.16	.32	.40	.15	.26	.34	.14	.41	.45
IQ	.18	.13	.10	.16	.13	.09	.15	.10	.08
Age			-5.50			-4.67			-2.66
FW			-1.06			2.04			.25*
MB			-4.44			-2.63			-4.12
FB			-4.58			-.76*			-4.78
% schools		40.0	33.3		24.0	18.7		64.0	53.3

Seventh Grade

Total Students: 3085; Total Schools: 44

$\bar{R}^2$	.20	.35	.40	.14	.26	.32	.17	.40	.43
IQ	.20	.14	.11	.16	.12	.09	.16	.10	.08
Age			-4.05			-3.77			-2.68
FW			-1.54			2.76			-.96
MB			-3.43			-.88*			-3.37
FB			-4.79			1.57			-4.33
% schools		46.5	31.8		18.2	15.9		54.5	50.0

Notes:

$\bar{R}^2$: is the adjusted coefficient of determination;

IQ: is the standardized score for a fifth grade administration of the Otis-Lenon;

Age: is the age in years;

FW: is a dummy variable for female-white;

MB: is a dummy variable for male-black;

FB: is a dummy variable for female-black;

% schools: is the percent of school's which differ from the comparison school at the 5% level of significance

An asterisk indicates that a coefficient fails to achieve significance at the 5% level.

Table 2: Means and Standard Deviation of Age and Test Variables

1970

	Fifth Grade		Sixth Grade		Seventh Grade	
	Means	SD	Means	SD	Means	SD
IQ	98.89	19.32	98.12	27.03	98.79	26.26
WK	27.6	12.0	33.96	12.5	27.9	11.53
SP	31.97	11.43	37.23	11.26	35.	10.8
ACMP	20.39	8.54	27.40	10.47	23.00	9.97
AGE	11.17	.61	12.18	.62	13.19	.64
MW	.31	.46	.32	.47	.31	.46
FW	.30	.46	.31	.46	.30	.46
MB	.19	.39	.18	.38	.19	.39
FB	.20	.40	.20	.40	.21	.41
N	2748		2885		3085	

Total School System (1972)

MW	FW	MB	FB	Others	Total	(Regular Schools, Non-Special Programs)
31.1%	27.6%	20.7%	20.3%	.4%	67,000	

FOOTNOTES

1. See, for example, the extensive literature review by McNamara of the application of mathematical programming models to educational planning. Also, recent discussions of the different aspects and problems associated with operationalizing the concept of "accountability" can be found in Barro [1970]; Glass [1972]; Mazur; Sciara and Jantz [1972]; Wrightstone, Hogan, and Abbot.

2. For example, in the accounting and management science literature see Ijiri [1965] and Demski [1967].

3. In particular Lopez (1970) observes several reasons why efforts to implement accountability systems have failed including unrealistic management, and unwilling and/or uncomprehending staff, low reliability and validity measures of accountability, and a misconception by management that accountability is an end rather than a means. Mazur also observes that "... to operationalize accountability so that it has an effect on shaping policies and life styles of schools on any significant scale, at least three ingredients are necessary in the early stages of implementation. Three ingredients are:

    1. Trained staff
    2. Opportunities to become accountable
    3. Capability to generate valid information as a basis for planning and development."

    The emphasis in our preliminary work has been to concentrate on 3.

4. Our definition of "accountability" is closely related to that of "management control" given by Anthony [1965], p. 17.

5. As is well known from economic theory, under a certain set of assumptions in a purely private competitive world, profit and utility maximization leads to a (pareto) optimal outcome. Unfortunately, education has many aspects of a public good which can lead to market imperfections. Further, the lack of information on the measurement of educational outputs can also lead to inefficiency. See, for example, Otto A. Davis and Morton I. Kamien, "Exteralities, Information and Alternative Collective Action", pp 74-95 in Robert H. Haverman and Julius Margoles, Public Expenditures and Policy Analysis, Markham Publishing Company, Chicago, 1970.

6. Our way of operationalizing the construct of accountability is related to Barro's [1970] Basic Analytical Problem in accountability measurement which he states "....is to develop a technique for estimating the contributions to pupil performance of individual agents in the educational process." p 201.

7. As Barro [1970] states, "Each participant in the educational process should be held responsible only for those educational outcomes that he can affect by his actions or decisions and only to the extent that he can affect them." p 199.

8. Fox and Sengupta [1968] have identified four aspects of the planning process at any level in an educational system which include (a) an analysis of basic variables, both quantitative and qualitative, in terms of instrumental and target variables, (b) an analysis of the over-all goals and its components, (c) the dynamic and sequential aspects which characterize the growth (or decline) in the system and the constraints imposed on feasible educational policy by preceding period outcomes and policies, (d) the effect of uncertain components on educational planning. We have concentrated on (a) and (b), with (b) being defined in terms of maximizing performance in certain educational cognitive areas. Although clearly important, the problems posed by considering (c) and (d) at this point are too complex in terms of the available data.

9. Wrightstone, Hogan and Abbot also include "a systematic method of feedback" in their list of components necessary for the application of accountability to the field of education. This, of course, is the dynamic aspect of a system which generates improved performance. Although these "feedback loops" will be introduced at some later point in our study, this preliminary investigation concentrate on the "static" aspects of the accountability system.

10. Obviously, more than one level of responsibility may be able to control an input variable and to this extent accountability must depart from the "all" and "none" category and be considered in manners of degree.

11. This approach is aimed at creating conditions which would yield a maximum chance of long-run implementation of the system, and would prevent some of the problems raised by Lopez [1970] in his discussion of why implementation fo accountability systems have failed.

12. Our initial approach to this aggregate relationship between inputs and outputs is related to, but different from, the models given by Sinha, Gupta, Sisson [1969]. We are concentrating on the school as the unit of analysis whereas they immediately constructed their model in terms of teacher/student ratio, space/student, and dollar expenditure of materials per student. Our next step is to include these as well as several other instrumental variables in the analysis in order to establish ex post those which best explain the school effects. To this extent we agree with the philosophy of Fox and Sengupta [1968] who state:

> "In the final analysis, of course, any model is restricted to a particular framework of assumptions and constraints, purposes at hand and approximations at large. However, we still believe that the specification of alternative logical structures (i.e., a set of consistent and flexible relationships between the most relevant variables characterizing an educational system) through alternative econometric models helps to a considerable degree in affording an insight into the possible interdependence of effects (and costs?) of alternative policies, the probable area of inoptimal decision-making and even the need for trading off of one subgoal for another in view of the final effect on the overall goal or objective of the system."

13. In the next section we discuss non-measurable (including non-cognitive) measures of output.

14. Of course, to fully evaluate the performance of a decision unit one must specify the set of alternatives which were available to the decision maker at the time the inputs and resources were used. To the extent that we can do this (and only to this extent) can we define a measure of desired performance against which we can measure the actual performance. This can also be accomplished by establishing standards of performance given estimates of the non-controllable factors.

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TABLE 8

Intercorrelations Between Linguistic Means and Communication Means
N = 100

	Variables	Variables								
		1	2	3	4	5	6	7	8	9
	Variables	Grade	Type	Token	Type/Token Ratio	Yules K	Token Length	Type Length	Sentence Length	Inter-Communication Score
1	Grade	1.00								
2	Type		1.00							
3	Token		.86	1.00						
4	Type/Token Ratio				1.00					
5	Yules K					1.00				
6	Token Length	.23					1.00			
7	Type Length	.28					.55	1.00		
8	Sentence Length	.36	.28			.20	.28	.24	1.00	
9	Inter-Communication Score	.51						.21	.41	1.00

Note: Correlation coefficients significant at and beyond .05 level are included in the table.